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ABSTRACT

This paper describes the multiple evaluation techniques which can be applied to one computer-based instructional system and the ways in which the data may be used. The Navy's Computer Managed Instruction (CMI) System is used as an example to illustrate the application of various evaluation strategies for solving problems associated with delivery system effectiveness, course material comparisons, variations of instructional strategies, and the daily management of instructional progress. Representative data are displayed which illustrate the uses of student data to facilitate the functioning of an operational CMI system. The uses are described on the basis of who actually uses the information for decision-making activities: the instructor, the schools, the system managers, or the instructional materials developer. (VT)

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THE MANY USES OF EVALUATION IN THE NAVY'S CMI SYSTEM

by

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The Many Uses of Evaluation in the Navy's CMI System

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Purpose

Although most large-scale computer-based instructional systems concentrate on providing effective instruction and measuring student achievement, a wide variety of evaluative operations can be performed using the primary data base generated from the basic student-system interactions. Unfortunately, school operators must devote the major portion of their efforts towards ensuring continuous and reliable instructional delivery. The possibilities for fully exploiting the evaluative capabilities of the computer and its data base frequently get lost in the shuffle of keeping the instructional system on-line and in serving the daily needs of the students.

The purpose of this paper is to describe the multiple evaluation techniques which can be applied to one computer based instructional system and the ways in which the data may be used.

In this instance, the Navy's Computer Managed Instruction system will be used as an example to illustrate the applications of various evaluation strategies for solving problems associated with: delivery system effectiveness, course material comparisons, variations of instructional strategies, and the daily management of instructional progress.

CMI System Description

The Navy CMI system consists of a centralized computer facility located in Memphis, Tennessee with schools sited not only in Memphis, but also in Orlando, Florida; Great Lakes, Illinois; and San Diego, California. Presently, the system is managing the instruction for over 6,000 students who are registered in nine schools under the command of the Chief of Naval Technical Training and it is expanding to a projected load of 15,000 students in 24 courses in five locations. This projected student load represents about 28% of the entire Navy technical training school population. Each school is made up of one or more learning centers. All the schools operate on a Keller-like model requiring 100% mastery of criterion referenced tests. Students spend 6 hours per day in a learning center. Although the physical layouts of the learning centers in Navy schools vary from school to school, the same instructional components exist in all centers. Generally, each center is located in a large room with one or more similar clusters or rows of individual study carrels for students to use while studying textual materials, an equipment area for conducting laboratory experiments or practicing with equipment, two testing areas (one for testing of knowledge skills and another for actual performance testing), a central location for the instructor, and an optical scanner and interactive keyboard/printer for communicating with the computer. Auxillary areas for distribution of instructional materials and equipment are

located nearby. The knowledge testing area will involve a number of study carrels in which microfiche card readers are installed. The student obtains the appropriate test microfiche card, completes the test at the reader, and then returns the card to the instructor. The study carrels are arranged so that one instructor may manage up to 30 students, although as many as 80 or 90 students may use the OPSCAN and keyboard/printer.

Diagnostic testing of subject-matter deficiencies is, of course conducted in the Navy CMI system. After completing the instruction for a module, the student completes the module test which consists of up to 50 five-alternative multiple-choice items. The answers are entered by the student onto a machine-readable answer sheet and then entered into the computer. After test grading, the computer tells the student which items were missed and makes a remedial study and test assignment. Generally, three forms of each test are available and are randomly assigned to a student to aid in preventing the students from merely learning tests and passing the answers to other students. The data are stored within the central computer located in Memphis. It is the function of various software programs to summarize the data and provide what data outputs are necessary to facilitate instruction either by aiding the instructor, the schools, the CMI system manager, or the developers of instructional materials.

For this paper, representative data will be displayed which illustrate the uses of student data which facilitates the functioning of an operational computer-based instructional system. The uses will be described on the basis of who actually uses the information for decision-making activities: the instructor, the schools, the system managers, or the instructional material developer.

Data Uses

One of the primary uses of data in the Navy CMI system is to facilitate the instructional progress of the students. This is accomplished through a Student Progress Report (SPR) which is provided on a daily basis to each instructor. A sample of the SPR is presented in Table 1. The reader is not expected to understand what every column represents without a lengthy explanation, however, it is instructive to describe a few of the columns.

The SPR lists the daily status of all the students in one learning center who are under the instructional control of a particular instructor. In addition to the students names there are codes to represent the particular job rating for which the student is working (CDP), the pattern of modules the student is assigned to (PAT), and the current instructional module the student is studying (MOD). The actual hours spent in module is indicated by the (THM) figure and the predicted number of hours (PHM) by the number immediately below the actual hours. The predicted number of hours for a module is determined using pretraining aptitude test scores, the number of years of civilian education, and the student's actual age as predictor variables. This prediction of instructional progress is extremely important, since many of the instructor's actions are based on a comparison of the actual time spent studying against the predicted study time. For example, if the student falls behind his

TABLE 1

PLEX G02363101 DATE: 27 SEP 77 — DAILY CMI STUDENT PROGRESS REPORT — COURSE: 045 — PROGRESS REVIEW
L/C E HRS=5.0 TIME: 07:21

SSN/SCN BR / NAME	CDP / PAT	MOD	***CURRENT MOD*** AHM / LHM	THM / PHM	PTC / CAL	ADD / LOST	AL / PL	ADJCT / PCT	PROG	REQ / ADD	***PERFORMANCE THRU LAST MODULE*** LEARNING RATE / PROGRESS RATE** -6	-5	-4	-3	-2	-1	LM	P G R	L 7 M	L 2 M	I N C	A P R	D P R	E X T	M O D
508-82-4392 61	6260	007	0	9	5	0	46	81	3+	.0	.50	2.08	1.39	1.21	.93	.97	.93		D						M
SAGERT PAUL D	B		5	7	19	0	49	87			.50	2.08	1.39	1.21	.93	.97	.93		D						
179-54-8849 55	6262	006	0	6	13	1	42	114	5+	.0	.00	.63	.60	.57	.58	.92	.90								
PITT JOSEPH E	A		0	18	18	5	46	126			.00	.63	.60	.57	.58	.91	.89								
441-66-1245 55	6262	011	3	22	4	11	112	154	5-	1.3	1.16	1.15	1.17	1.14	1.13	1.13	1.16								
PRICE ALBERT	A		2	21	36	0	97	133			1.05	1.05	1.06	1.01	.99	.99	1.04								
155-48-2626 61	6260	004	0	7	8	0	9	7	7+	.0	.00	.00	.00	.66	.73	.54	.54								
HALL LEWIS H	B		0	15	5	0	16	88			.00	.00	.00	.66	.73	.54	.54								
366-72-3791 61	6260	005	1	2	16	2	45	127	5-	1.2	.00	.00	.60	1.83	1.44	1.15	1.18								
GRAFT JAMES W	B		0	6	14	0	38	108			.00	.00	.60	1.83	1.44	1.15	1.12								
366-64-8106 61	6260	006	0	10	6	0	29	69	14+	.0	.00	.37	.70	.58	.58	.62	.67								M
MILLS KEITH A	B		0	15	14	5	43	103			.00	.37	.70	.58	.58	.62	.67								
303-56-3030 61	6260	010	0	0	5	0	69	94	7+	.0	.63	.86	.97	.96	.89	.87	.90		D						
KIRK DOUG E	B		0	12	21	0	76	104			.63	.86	.97	.96	.89	.87	.90		D						
412-98-7561 55	6262	006	0	12	8	2	30	81	18+	.0	.00	.28	.66	.70	.62	.65	.64								M
WEAVER WILLIA	A		0	17	13	0	46	127			.00	.28	.66	.70	.62	.61	.60								
205-38-5394 55	6262	000	0	0	0	0	0	0		.0	.00	.00	.00	.00	.00	.00	.00								
MENSHAW CRAIG	A		0	0	1	0	0	0			.00	.00	.00	.00	.00	.00	.00								
452-15-4139 61	6260	012	0	2	3	4	117	134	5-	1.4	1.09	.99	.97	1.03	1.07	1.06	1.07								
PEREZ EMILIO	B		0	10	36	7	109	125			1.02	.95	.92	.99	1.04	1.03	1.04								
498-70-0201 57	6261	003	0	2	10	0	7	59	5+	.0	.00	.00	.00	.00	.28	.72	.60								M
CUNDIFF RICHA	A		0	3	5	0	12	98			.00	.00	.00	.00	.28	.72	.60								
497-70-1252 55	6262	006	0	7	10	1	33	85	15+	.0	.00	.51	.48	.50	.54	.59	.64								
RIFFIN JEFF	A		0	14	12	0	46	125			.00	.51	.48	.50	.52	.57	.67								
457-56-5957 55	6262	011	0	13	4	5	95	129	9+	.0	.88	.88	.98	.96	.98	.98	.96								
[illegible]	A		0	21	32	0	99	134			.84	.85	.95	.90	.92	.92	.90								
25-17-4217 61	6260	001	0	1	0	0	1	0		.0	.00	.00	.00	.00	.00	.00	.00		D						M
[illegible]	B		0	8	1	0	1	104			.00	.00	.00	.00	.00	.00	.00								

[illegible] D=10 /L2% I=05% D=05%/INC 75%COMP C=50% F=33 /APR= 40AYS/DRP=30%/EXT*RADD W2.0 M3.0 B4.0*DFR X=30% Y=10%/MOD= HRS

predicted completion time, the computer generates the amount of extra study time (REQ ADD) the student would have to spend every day in order to complete the course at the original predicted time. Other information tells the instructor how the student did in the seven previous modules via the learning rate (LEARNING RATE) information. Learning rate is literally a comparison of the ratio of actual over predicted number of hours studying. Hence, a number over 1.00 indicates a student took longer than the predicted time. By comparing these learning rates across a series of modules, represented under the figures -6, -5, -4, -3, etc., the instructor can detect a trend in the student's study behavior. The columns at the right side of the SPR are flags to alert the instructor to various events. For example, the PGR column indicates when the student has 3, 2, or 1 modules remaining before completing the course. The instructor can take certain administrative actions to expedite the student's transfer. Criteria for these various flags are set by each school.

These SPRs are quite important to the instructors as it is the only way the instructor can determine that a student is progressing adequately when "passing" a test based on 100% mastery and the students are progressing at their own rate. What is also patently necessary is that the initial predicted completion times be accurately determined for each individual student. Obviously, any deviation from the "real" expected time for completion will either penalize the student by setting too rapid a completion rate or will penalize the school by setting too lenient a standard. It is a research function to continually monitor the prediction equations and improve the predictive capability of the system.

The schools may use the SPRs but generally do only in those cases where a student has been brought before an academic review board. At some point, set by the school, the slow student will be attrited from the school for inadequate performance. When making this decision the school review board will actually obtain from the computer a Response History File which describes in detail the progress of the student, including every response to all test questions. (Including an illustration in this paper of a Response History File would be a waste of space, but be assured that all student information is available.)

Other data uses are made by the school in terms of general record keeping. There are standard printouts which will list summary information about school graduates or school attrites. These summaries include listing individual students, their aptitude level, total hours in course, predicted time in course and prospective job assignment code.

The CMI system manager also uses these summary sheets for each school for making system evaluations. The system manager can also request special test data summaries to compare schools during certain time periods or for certain kinds of students, high or low mental level, for example, Generally, the system manager would not be using the Response History File or the Student Progress Report. It should be noted that the system manager is responsible for making any changes in any of these reports so that office does has an obligation to keep informed of its effectiveness and recommend changes.

Instructional materials developers have a need for data in order to revise materials or tests. To satisfy this need the CMI system has an Item Analysis program which can provide summary item data for any test. A sample of the Item Analysis report is presented as Table 2. Again, time and space dictate against a detailed explanation, but some information is obvious. For each item, it is possible to determine how many students responded with each of the response alternatives, the P-value or percent correct, and the number of students missing the item on the basis of students who scored high or low. From table 2 it is apparent that certain items in this particular test are in need of change. All of the other data summaries are also available to the materials developers and they use that information for making constructive changes.

The research community has access to the data through the CMI system manager. In fact, it is a major responsibility of the investigators to be responsive to the needs of the Navy CMI system manager. Accordingly, it is the researchers responsibility to make accurate use of the available data in order to make valid recommendations for system changes. A recent instance of the research use of data involves the comparison of two similar courses and their effects on a subsequent non-individualized course. In this case, it was necessary to extract data from the CMI system and correlate it with data from non-CMI school data. By doing this, it was possible to inform the CMI system manager of the comparative benefits of the two CMI courses with the effects on the subsequent follow-on training.

Ideally, all of the training data would be accessible from the same computer data base and the difficulty of combining computer data with non-computer data could be avoided. That task is also part of the research community's function and will be undertaken in the following year.

Conclusion

Organizations using computer-based instructional systems should optimize the data handling fucntion of the computer by establishing a multiplicity of evaluation procedures within the computer itself. These procedures can be used not only to aid in individual student achievement such as the student Progress Report in Navy CMI, but also to provide system administrators the summary evaluations which they need for making revisions in course materials, tests, or media delivery options. Ideally, the integration of system instructional objectives with appropriate evaluation procedures would occur prior to acquisition of the computer system and would result in well-defined and planned operational procedures for using the wealth of data that are stored in any computer-based instructional system. With the computers technology now available, there is no excuse for not using the information.

In our research organization (NPRDC) like many of you, we are faced with attempting to change an existing system and adding data-base management functions. Although difficult, this is an important task, since data management is the one function that the computer can most supremely facilitiate and thereby support its own continued existence in an instructional context.

TABLE 2

CMI RESPONSE HISTORY -- ITEM ANALYSIS -- TEST:ITEM # 1003

ST. #	N	#MISSED	#ANS 1	#ANS 2	#ANS 3	#ANS 4	#ANS 5	CORR	LO-WRONG	HI-WRONG	P-VALUE	DIST.	SKEW
1	376	47	6	2	329	20	19	3	19	9	0.875-9900.000		24.100
2	377	5	372	3	2			1	3	0	0.986 100.000		4.700
3	377	3	2	1	374			3	2	0	0.992-9900.000		3.100
4	377	10	7	367	1		2	2	3	1	0.973-9900.000		4.100
5	377	44	16	333	16	5	7	2	12	5	0.883-9900.000		15.700
6	377	13	364	4	8	1		1	10	0	0.965 100.000		15.800
7	377	13		3	364	8	2	3	6	1	0.965 100.000		8.900
8	376	19	1			357	18	4	14	0	0.949-9900.000		22.200
9	377	15	3	3	362	1	8	3	10	0	0.960-9900.000		15.800
10	377	11	366	5	2		4	1	7	1	0.970 100.000		10.500
11	377	12	365	6	1		5	1	6	0	0.968 100.000		9.500
12	377	35	2	3	17	342	13	4	22	3	0.907-9900.000		32.900
13	377	33	1	344	9	12	12	2	17	0	0.912-9900.000		26.900
14	377	34		31	343	1	2	3	20	2	0.909 100.000		30.400
15	377	11	4	1	366	1	5	3	5	0	0.970-9900.000		7.900
16	377	71	306	2	57		12	1	25	6	0.811 100.000		35.600
17	377	12	10	2	365			3	6	0	0.968-9900.000		9.500
18	377	1-	8	10	359			3	10	0	0.952-9900.000		15.800
19	377	17	3	14	360			3	11	0	0.954-9900.000		17.400
20	377	24	353	23	1			1	16	0	0.936 100.000		25.300
21	376	24	24	352				2	15	0	0.936-9900.000		23.800
22	375	191	53	42	90	195	15	4	50	43	0.493-9900.000		50.300
23	377	32	246	10	9	5		1	14	0	0.915 100.000		22.200
24	377	60	54	317	1			2	27	0	0.840-9900.000		42.800
25	377	71	303	58	9	5	1	1	30	1	0.819 100.000		47.000
26	376	15	4	341	4	1	4	2	11	0	0.960-9900.000		17.400
27	377	-		1	371	3	2	3	4	0	0.984 100.000		6.300
28	377	21	5		12	356	4	4	13	1	0.944-9900.000		20.600
29	377	41	1	41	1	334		4	19	0	0.895-9900.000		30.100
30	377	29	2	2	322	11	41	3	26	1	0.854-9900.000		41.600
31	376	13	3	347	1	1	4	2	8	0	0.976-9900.000		12.600
32	376	9	4	347		3		2	7	0	0.981-9900.000		11.100

								AVG. TIME	P-VALUE	LO MEAN	HI MEAN	SKEW
1-32	377	27	43		31	14		1.0	.91	24.277	31.500	29.3